K/Ar and 40Ar/39Ar Laser-Probe Ages of Metamorphic Micas and Amphibole of the Wilson Terrane and Dessent Unit, Northern Victoria Land (Antarctica): Their Bearing on the Regional Post-Metamorphic Cooling History

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Received 31 March 1993; accepted in revised form 4 August 1993

Abstract - K/Ar and 40Ar/39Ar single-grain ages are reported for 50 biotites, 3 muscovites plus one amphibole from the Wilson Terrane and the adjacent Dessent unit in northern Victoria Land. The results indicate that the post-metamorphic cooling history during the Ross Orogeny is almost certainly identical and rapid for both units with very consistent 40Ar/39Ar mineral ages clustering around 477 Ma. K/Ar biotite ages show no correlation with the regional metamorphic grade but seem to reveal four spatially distinct age groups. Average ages calculated for each of these groups increase away from the Priestley-Tinker zone, where the average K-Ar age is 455 Ma both to the west, where a mean value of 466 Ma is found in the O’Kane-Priestley zone, and to the east where values of 469 and 480 Ma are calculated for the Tinker-Icebreaker and Retreat Hills-Mt. Murchison zones, respectively. Such age variations possibly reflect regional variations in uplift rates and/or local deformational history, but they need further 40Ar/39Ar confirmation.

INTRODUCTION

Three major tectonometamorphic units (terranes) are currently recognized in northern Victoria Land (NVL), from W to E, the Wilson, the Bowers, and the Robertson Bay Terranes. The Wilson Terrane, now generally considered as a part of the East Antarctic Craton re-activated in early Paleozoic times (Borg et al., 1987; Kleinschmidt & Tessensohn, 1987; Lombardo et al., 1991), is characterized by monometamorphic metasediments of low- to high-grade and by an older basement complex with relics of granulate facies rocks. Both the metasediments and the basement complex are intruded by syn- to postkinematic Cambro-Ordovician granitoids. A small tectonometamorphic slice, the Dessent unit, has recently been distinguished between the southern portions of the Wilson and Bowers Terranes (Fig. 1). The distinction is based on its peculiar lithology (zoisite amphibolites with metapelite layers and marbles) and metamorphic history, characterized by a peak event of kyanite-staurolite grade followed by a greenschist-facies retrogression (Capponi et al., 1988; Capponi et al. in press; Scambelluri et al., in press).

This short paper reports on a geochronological study aimed at better constraining the regional cooling history of both the Wilson Terrane and the Dessent unit. K/Ar and 40Ar/39Ar single-grain dating of metamorphic micas and one amphibole was performed on samples collected along two main traverses (Fig. 1). NNW - SSE trending traverse A is 60 km long and follows the eastern border of the Wilson Terrane and the adjacent Dessent unit from the Retreat Hills to the Ross sea coast. SW - NE trending traverse B intersects the southern portion of Wilson Terrane exposed along the coast from Mt. Nansen to Mt. Murchison.

RESULTS AND INTERPRETATION

Traverse A - The 22 biotites analyzed along this profile (Vita & Lombardo, in press) display K/Ar ages ranging from 465 to 491 Ma (Fig. 2) and a single significantly lower value of 344 ± 4 Ma (southern ridge of Mt. Murchison), which probably results from partial Ar loss due to the proximity (about 5 km) of the Cenozoic Cape King pluton (Fig. 1). Excluding this sample, the weighted average of the biotite K/Ar data yields a value of 480 ± 4 Ma. The weighted average of 477 ± 4 Ma shown in figure 2 also includes the samples of the Dessent unit as discussed below. 40Ar/39Ar single-grain analyses of three biotites that yielded K/Ar ages spreading between 472 ± 6 Ma and 491 ± 6 Ma provided a very narrow range with well-defined plateau ages clustering between 477 ± 2 Ma and 480 ± 2 Ma. These single-grain ages are in striking accordance with the mean K/Ar age calculated over the whole Retreat Hills - Mt. Murchison area, i.e. 480 Ma. Two muscovites investigated with the laser probe also yielded 478 ± 2 Ma plateau ages, indistinguishable (within error bars) from the dates of the associated biotites and from the mean K/Ar value. The convergence of all the 40Ar/39Ar biotite and muscovite data around 477 Ma provides a powerful constraint on the regional metamorphic evolution. The
close age coincidence found for biotite-muscovite pairs suggests that this portion of the Wilson Terrane underwent a relatively fast post-metamorphic cooling through the temperature interval for effective Ar retention in micas (between ca. 300°C and 400°C, McDougall & Harrison, 1988).

K/Ar biotite ages from the adjacent Dessent unit fall in a slightly lower range of 459-473 Ma that partially overlaps the K/Ar age range found in the Wilson Terrane (Fig. 2). One discordant lower age of 434 ± 4 Ma is also found in this area, not far from the Cape King pluton (Fig. 1) once again suggesting some localized effect of partial thermal resetting. Like in the Wilson Terrane, 40Ar/39Ar single-grain analyses in the Dessent unit resulted in a tight grouping of ages with very consistent plateau ages of 475 ± 2.5 Ma, 477 ± 3.0 Ma, and 477 ± 3.0 Ma, obtained on two biotites and one amphibole, respectively. The occurrence of identical, very well-defined single-grain plateau ages around 477 Ma both in the Wilson Terrane and the Dessent unit strongly suggests a common cooling and uplift history for these units in spite of their different lithology and P-T evolution. Furthermore, the concordance of the single-grain biotite and amphibole plateau ages in the Dessent unit also lends support to our suspicion of a relatively fast post-metamorphic cooling over the entire area.

Traverse B - At the regional scale the K/Ar biotite ages obtained in the Wilson Terrane along this traverse (Mt. Nansen - Mt. Murchison, Fig. 3) vary between 434 and 494 Ma (Vita et al., 1991). They fall into the same age range obtained with the K/Ar and Rb/Sr methods by Borsi et al. (1987) and Armienti et al. (1990) on igneous rocks from the same area, and by Adams and Kreuzer (1984) and Kreuzer et al. (1987) on igneous and metamorphic rocks further North in the Wilson Terrane. The K/Ar biotite ages show no correlation with the regional metamorphic grade but seem to reveal four spatially distinct age groups (Fig. 2) corresponding, from SW to NE, to the areas between (1) the O’Kane and Priestley Glaciers, (2) Priestley and Tinker Glaciers, (3) Tinker and Icebreaker Glaciers, and (4) Retreat Hills and

![Diagram](image_url)

**Fig. 1 -** Schematic geological map of the area between David and Mariner Glaciers (northern Victoria Land, Antarctica). K/Ar and 40Ar/39Ar sampling traverses A (Fig. 2) and B (Fig. 3) are marked by heavy lines. 1 - McMurdo Volcanics; 2 - Beacon and Ferrar Supergroups; 3 - Bowers and Robertson Bay Terranes; 4 - Cambro Ordovician Intrusives; 5 - Metamorphic complexes of the Wilson Terrane; 6 - Dessent unit.
Fig. 2 - K/Ar and 40Ar/39Ar mineral ages along traverse A between the Retreat Hills and Mt. Murchison (Wilson Terrane), including data from the adjacent Dessent unit (Disthen Wand and Dessent Ridge). The dashed line represents the average K/Ar age (477 ± 4 Ma) integrated over the whole traverse. Note the tight regional concordance of the 40Ar/39Ar ages around this mean K/Ar value both for the Wilson Terrane and Dessent unit.

Fig. 3 - K/Ar and 40Ar/39Ar mineral ages along traverse B between Mt. Nansen and Mt. Murchison (Wilson Terrane), including data from the adjacent Dessent unit. Dashed segments represent the weighted average of K/Ar ages calculated for the different age domains discussed in the text. Also shown is a single 40Ar/39Ar biotite age of 477 Ma for a biotite concentrate from the Priestley Glacier area (dated at 454 Ma by the K/Ar method).
Mt. Murchison. The weighted average ages calculated for each of these domains increase away from the central Priestley-Tinker Glaciers zone, where the average K-Ar age is 455 Ma. To the west a mean value of 466 Ma is found in the O’Kane-Priestley zone, while to the east values of 469 and 480 Ma are calculated for the Tinker-Icebreaker and Retreat Hills-Mt. Murchison zones, respectively. A similar age pattern was found by Adams and Kreuzer (1984) in the northern Wilson Terrane between the Usarp Mountains and Lanterman Range, where the average mineral and whole rock K/Ar ages increase eastward from 455-480 to 455-500 Ma.

The regional K/Ar ages reported here may be interpreted as cooling ages recording the closure time of the Ar isotopic systems. Hence, the regional age variations, which are apparently also recorded by local Rb/Sr data (Armienti et al., 1990), could suggest:

1) Ordovician basement faulting with a diachronous post-metamorphic cooling, possibly as a result of regional variations in uplift rates (Armienti et al., 1990; Vita et al., 1991), and/or

2) variable degrees of re-opening of the mica K/Ar isotopic system due to continuing late- to post-metamorphic deformation in localized zones of the area.

Both interpretations are speculative, however, and await further confirmation from $^{40}$Ar/$^{39}$Ar data. More data, in particular are needed to prove that the observed regional K/Ar age distribution does effectively correspond to real cooling age variations rather than to some data scatter about a single, regionally meaningful value as is the case in traverse A (Fig. 2). Preliminary $^{40}$Ar/$^{39}$Ar bulk sample analysis of a biotite concentrate with a K/Ar age of 454 ± 6 Ma from the Lowry Bluff locality (Fig. 1) revealed a flat age spectrum slightly disturbed by minor chlorite contamination, but with a total-gas age of $477 ± 2$ Ma (Fig. 3) fully consistent with the other $^{40}$Ar/$^{39}$Ar data.

ACKNOWLEDGEMENTS

This work has been carried out with the financial support of the Italian Programma Nazionale di Ricerche in Antartide.

REFERENCES


